Towards Success in Higher Education in Engineering and Technology:

A coaching approach to develop holistic graduates

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***Abstract*—** There is a growing gap between engineering practice and engineering education that may be contributing to less engineers practicing in industry. Coaching approach to learning and teaching has been proven to be an effective way to develop people in the workplace. A pilot coaching program is offered to Engineering and Technology students in Queensland University of Technology to enable holistic growth in order to better integrate them to the work force and society at large. The results and findings of this program will be published once the program has been completed.

Keywords- Mentoring; Engineering Leadership; Life Coaching; Higher Degree Research; Success Factors

I. INTRODUCTION

Higher education plays a crucial role in the economic and social progress of a nation, with higher education training affording graduates to meet the needs of business, governments, industry and branches of society Overall, an outstanding higher education system is deemed essential to maintain a high standard of living and a balanced society.

The resource boom in mining in particular has left Australia facing a severe shortage of engineers, with a growing demand for skilled engineers in the industry. According to the senate inquiry held in 2012 into the shortage of engineers *"Australia produces less than half of its current annual engineering workforce needs. Even with Australian universities and TAFEs producing around 9,000 graduates annually, Australia is still unable to provide a reliable domestic solution to these key shortages"* [1]. This calls for Australian higher education institutions to increase the intake of students and promote engineering education at all levels to meet the local demand.

Despite the growing demand for engineers, there is a growing gap between engineering practice and engineering education [2, 3]. The notion that engineering practice is technical problem solving and design has been challenged given that engineers spend a large proportion of their time dealing with people, which existing models describing engineering practice fail to address [3]. It is also becoming more evident that there are a set of non-technical skills that engineers need to be in possession of in order to be successful practitioners in industry [2]. There is a significant percentage of engineering graduates with Australian degrees who do not secure employment as engineers, arguably as a result of lacking in these essential non-technical skills [4]. These are described as soft skills [5]. These 'soft skills' and are seen to play an important role from securing employment, to fitting into the work culture and ultimately progressing through to management [4].

While a majority of this applies to international students and migrant residents from non Caucasian ethnic backgrounds, it raises concern for the future of engineering practice given that a significant percentage of engineers who work in industry are from a foreign background, with an increasing percentage graduating from engineering programs offered within Australia [4]. The Australian education system, especially the universities, have been responsible for building the nation's third largest export industry over the last two decades with one quarter of the higher education students coming from other countries, especially Asia, making an enormous contribution towards the economy [6].

Aware of this gap between education and practice, there have been attempts to model engineering practice by incorporating nontechnical skills with the recommendation that engineering educators develop curriculum that incorporate these skills [7].

The coaching approach to learning and development is increasingly growing in popularity and effectiveness in workplaces due to its self-directed approach to taking action. The International Coach Federation defines coaching as "*partnering with clients in a thought-provoking and creative process that inspires them to maximize their personal and professional potential"* [8]. Coaching has been

shown effective in delivering effective learning outcomes at tertiary level [9] assisting students as well as staff [10, 11]
As a relatively new field, coaching is a methodology that draws on a range of other more traditional professions including psychology, business consulting, mentoring management theory and adult learning. However, coaching is a unique field and there are significant differences between coaching and these fields. Coaches are trained to listen, to observe and to customize their approach to individual client needs. They seek to elicit solutions and strategies from the client; they believe the client is naturally creative and resourceful. The coach's job is to provide support to enhance the skills, resources, and creativity that the client already has. Given this approach to learning and development, we believe the coaching approach may hold the key to bridging the gap between education and practice and help develop better rounded graduates.

This paper describes a pilot coaching program that is being developed to be implemented among Higher Degree Research (HDR) students in Engineering and Technology disciplines, at Queensland University of Technology (QUT), to better facilitate holistic success of the research student. We aim to report the results of this study, its measurable outcomes and lessons learnt once the study has been completed as well as the applicability of the coaching style approach to learning and supervision in higher degree research in engineering and technology.

II. METHODOLOGY

A. *Introduction*

The pilot coaching program will be conducted among 20 Engineering PhD research students from the Faculty of Science and Engineering (SEF) at the Queensland University of Technology (QUT). The cohort chosen will be a mixture of males and females, from years 1-4 in the PhD program and from differing cultural backgrounds, representing the diversity of the faculty. Participation in the program will be on a voluntary basis, with the written consent from the respective supervisors, who also participate in the program in order to support and assess the students at critical stages in the program. The program consists of a 9-Step process and the participants are expected to cover all 9 steps, each step building on the other and fulfil the basic competency criteria in order to successfully complete the program. Evaluation of success will be made on the basis of personal and academic goals set by the participants in consultation with their supervisors for the latter. Additionally, the program will aim to meet competencies of stage-1 under professional and personal attributes of an engineer, stipulated by the Institute of Engineers, Australia, the governing professional body, responsible for engineering practice in Australia [12].

B. *The Coaching Model and Program*

The coaching program was created around a professional coaching model called P^3-GROWTHS [13] that espouses the values of experiential and life-long learning and draws on the principles of biological or natural growth as seen in nature, (Fig. 1). Growth is seen to occur in 3 progressive stages as captured by the P^3's termed *presence*, *purpose* and *partnerships* represented by the 3 rings. This is similar to how a seed germinates and anchors to the soil (*presence*), develops a shoot system that promotes vertical growth (*purpose*) and develops leaves and branches that helps spread out (*partnerships*) that result in the tree bearing fruit. *Presence* is seen as the quality that helps people connect with themselves through self-awareness and with others that promotes trust, the essential quality for the flourishing of any relationship. *Purpose* is seen as the clear ability to be self-decisive, to plan and set goals towards a clear purpose that results in change and growth. *Partnerships* is the extent of one's ability to form a supporting structure and gather resources in order to achieve the set purpose or goals. The 3P's, *presence*, *purpose* and *partnerships* essentially define the depth, height and breadth of all relationships respectively.

Figure 1 P^3-GROWTHS Model reproduced with permission from Full Life Coaching®

Holistic growth is seen as the extent to which a person can develop in all three dimensions. The P^3-GROWTHS model is developed to essentially capture the uniqueness of the individual and promote 'structural growth' as it relates to an increase individual capacity and 'functional growth as it relates to the quality and diversity of a person's interactions with the outside world. The process of coaching a person towards growth and development by moving towards specific goals is captured in the acronym GROWTHS. Each

coaching success is seen as a seed for promoting growth in another area of the person's life or passing on to another individual through mentoring or coaching, in the true spirit of sustainability. The role of the educator or coach in this regard is to help develop the individual towards their fullest potential, providing the support structure and the ingredients for growth be it knowledge, resources or opportunities.

The 9 steps program,(Fig. 2) is developed in order to capture the essence of the 3 growth factors of Presence, Purpose and Partnerships as it relates to 3 different levels of relationships; I (with oneself), YOU (with another) and WE (with a group or audience).

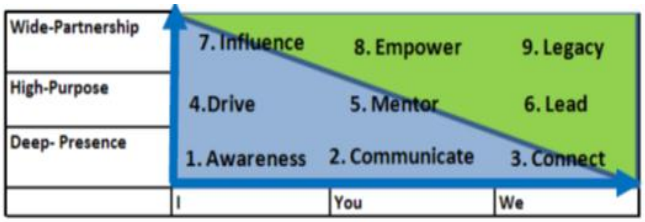

Figure 2 The P[3]-GROWTHS Coaching Program©

The pilot program will run for 12 months and in two stages of 6 month duration.12 monthly workshops will be conducted aimed at developing specific skills and competencies ranging from developing self-awareness to self-management and self-leadership, developing a vision and a life purpose to effective goal setting, developing a personal brand, peer mentoring, leadership, life-long learning, sustainability, innovation and creativity, handling diversity and responding to conflict, communication skills specifically listening skills, the art of connecting, team dynamics and leaving a legacy. The workshops will be supplemented with periodically scheduled one-on one coaching by an experienced coach and through a series of peer coaching sessions, where participants will coach each other. The individual sessions with an experienced coach will help bring focus on the specific goals of the student and make the program personalized to their needs, in addition to the skills developed through the workshop activities.

C. Effective Delivery

In stage 1, coaching will take place via 6 workshops covering steps 1-5 of the program with 3 individual personal coaching sessions by a professional coach, while stage 2 will cover steps 6-9 via 6 coaching workshops and 3 individual personal coaching sessions with the addition of 3 peer coaching sessions, where each participant will be required to coach and be coached by a fellow participant for 3 sessions each, using the P[3]-GROWTHS model. The format of delivery, assessment and evaluation is given in Table 1.

TABLE I. FORMAT OF DELIVERY FOR P[3]-GROWTHS PROGRAM

Month	Program Format			
	Workshop	**Coaching**	**Assessment**	**Evaluation**
Stage 1 Start		Coach assigned based on *Coaching Readiness Survey*	*Coaching Readiness Survey* Goal Setting 1 -With experienced coach on life issues and academic goals with supervisor	*Student Survey -1* *Supervisor Survey -1*
Months 1-6 End	6 Monthly Workshops	Sessions with experienced coach in months 1,3 & 5	Workshop specific requirements Attendance criteria Stage 1 Goal assessment	*Student Survey -2* *Supervisor Survey -2*
Stage 2 Start		Peer coach assigned	Goal Setting 2 -With experienced coach on life issues and academic goals with supervisor	
Months 7-12 End	6 Monthly Workshops	Sessions with experienced coach in months 7,9 & 11 3 Sessions coached by peer Coach	Workshop specific requirements Attendance criteria Client Coaching- 3 sessions peer coaching eval received Stage 2 Goal assessment	*Student Survey -3* *Supervisor Survey -3*

To ensure the successful running of the program and maintain the integrity of the coaching process, which can be summed up as developing self-awareness, becoming self-decisive about change and taking self-directed action towards that change, the following guidelines will be followed based on the recommendations of Huston and Weaver [10].

a. Goal Setting- All forms of goal setting, personal and academic as part of the program will be done by the participant at any given stage of the program, to ensure total ownership of the process, as the effectiveness of coaching is about taking self-directed action and ownership of the goals and the course of action taken to

reach the outcome should at all times be owned by the participant.

b. Voluntary Participation- Following on the heels of ownership, it is vital to ensure that all participation is voluntary and at no time any participant is feels pressured or coerced, in any given part in the program as a lack of willingness affects their ability to achieve goals. This means that should the individual circumstances change in a given participant during the course of the program, allowances should be made to accommodate that. The same applies to if a participant chooses to discontinue the coaching relationship citing a lack of 'coaching-fit' meaning that the relationship is not working for either or both parties.

c. Confidentiality- It is essential to maintain a high level of confidentiality as far as the contents of discussion within the coaching relationship is concerned. The participants will be identified only as taking part in the program as it involves their supervisors, but no details of their progress will be released. The data from the surveys and individual goals will only be available to the experienced coaches and not to the faculty or the supervisor of the participant, so as to avoid any bias towards the participant.

d. Assessment- It is important to ensure a uniform standard is maintained across the program. The main forms of assessment for successful completion of the program will be participation in all the workshops (or viewing the video recording where they have failed to attend) the required one-one coaching sessions with experienced coach and two way peer coaching sessions. Records of participation will be maintained for statistical purposes, without identifying individuals by name and their feedback will be used for evaluation purposes by maintaining anonymity. Participants will be encouraged to obtain feedback from their coaches and coaches towards self-assessment and Improvement but no records will be kept of the individual feedback within sessions to maintain confidentiality.

e. Evaluation-There will be a formative evaluation as far as the effectiveness of the running of the program is concerned at the end of stage 1, where all the participants and experienced coaches will give feedback through a questionnaire on how the program can be improved, so that these improvements can be accommodated in stage 2. There will also be a summative evaluation of the program as a whole at the end of stage 2, done by the participant and their coaches alike, especially on the unique aspects of stage 2, namely on peer coaching. Additionally there will be ongoing adjustments based on participant feedback to enable flexibility so that the program requirements don't compete for time with their formal research.

f. Institutional Support- It is vital that the program has the patronage of the Science and Engineering faculty, especially the dean, HDR office, the heads of schools and the respective supervisors of the participants. This support needs to be conveyed in meaningful ways and promoted as such through newsletters, faculty level advertising and featured as a new initiative to support the learning and teaching efforts in higher degree research. Acknowledgement of the role of coaching and providing incentives monetary or otherwise for successfully participating in the program will encourage participants and coaches alike and will send out a clear message to the supervisors, and other personnel at the school and faculty levels of the commitment required to ensure the successful delivery of the program. Such acknowledgement will reinforce the efforts at all levels of the program and encourage better performance overall.

III. EVALUATION & DISCUSSION

A. Short Term Impact

Qualitative and quantitative data will be gathered at 3 stages in the program (Table 1) using surveys which will be used to evaluate the effect of coaching on the students. The comparative scores from the separate surveys will form the basis for the short term effectiveness of the coaching process in relation to helping the participants achieve their respective goals. Given the subjective nature of the evaluation of success, a comparison statistical analysis will be carried out to assess the perceptions of the students to that of their supervisor's on the progress they have made and 'success' they have achieved. The feedback comments from the surveys will enable a qualitative analysis to be made on the effectiveness of the program as seen by the students and supervisors alike.

B. Medium-Long Term Impact

Although the scope of this study enables evaluation of specific goals over the duration of the program, the type and nature of the goals set by the participants may mean that the total impact of the coaching program can only be effectively evaluated 1-2 years after the completion of the program. For instance, a participant may set a career related goal half way through the PhD program and would have taken action to work on learning a set of specific skills with the intention of achieving their goal, which in reality can be measured once the PhD program is completed and the participant enters the workforce. Hence it will be important to device means to capture the medium to long term impact of the program and get relevant data 1-2 years after the program.

Some key questions to ask in this regard will be:

- How has the student's overall 'efficacy' as it relates to motivation, enthusiasm and the creative problem solving ability, improved 1-2 years after the program?
- What specific change of impact is the student having in his immediate research community? For example is the student seen to contribute more to the research ideas, support the efforts of other peers, seen to mentor the younger members of the team, and generally more available to help, when help is sought out?
- What effective partnerships is the student fostering within and outside the research community that have a direct impact on the outcomes of the research and beyond?
- How does the completion time of the student compare with the average completion times for that degree program within the faculty?
- How soon after finishing the PhD was the student able to secure full time employment and in an area of first preference?

C. Relevance of Coaching to HDR students

The results of this program will overall enable to measure the effect coaching has on the development of HDR graduates towards holistic success where the process is driven by the student from start to finish. The lessons learnt from this study will enable an evaluation of the current teaching and learning practices, research supervision and the support services available for HDR students at the university level to be further enhanced by incorporating the coaching approach to the delivery of these services. In the learning and teaching area for HDR's, this means flexibility to for learning outcomes to be set by the students and the ability make decisions with regards to the approach taken to achieve them. This will enable students to drive the learning and research process more and have more ownership of their research outcomes. Supervision style will also benefit from a coaching approach in that the students will feel that the supervisors are not dictators or employers with superior knowledge as the following comment implies, but as facilitators of the learning and research process. *"My supervisor sometimes thinks that he knows everything about my research. He does not give me a chance to express my ideas and I feel this is due to my English not being so good. And also I am quite shy*" [14]. Furthermore, the coaching approach to supervision would enable the supervisor to have a greater awareness of the student needs and provide more pastoral type of care that HDR student indicate they need from their supervisor, which supervisors may not be aware of or may not see as part of their role in supervision [15].

IV. CONCLUSIONS

The current paper advocates the need to formulate a broader definition of success for engineering and technology graduates to promote holistic growth in them and better integrate them to the work force and society in general. Coaching as an approach to learning and teaching in this context is a means help develop the person holistically so as to produce better coherence and consistency between engineering education and practice.

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